THE EFFECT OF CLIPPING VERSUS GRAZING ON PLANT SURVIVAL, BOTANICAL COMPOSITION, YIELD, QUALITY OF FORAGE AND ROOT GROWTH OF BIRDSFOOT TREFOIL, *(LOTUS CORNICULATUS L.)* AT URBANA, ILLINOIS

BY

JOSEPH JULIAN PIERRE

B.S., University of Wisconsin, 1932
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1952

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Introduction

Illinois has about 2,160,000 acres of land which is classified as non-rotational open permanent pasture. Since much of this acreage is located on steep terrain subject to erosion, and because of the work and expense that would be required to renovate these pastures periodically, there is need for a perennial legume which can be depended upon to produce a high yield of forage year after year following its establishment.

Observations in Illinois and eleswhere indicate that birdsfoot trefoil (*Lotus corniculatus* L.) is persistent enough to maintain a stand indefinitely after its establishment in a permanent pasture.

Information in regard to the management of birdsfoot trefoil is lacking; therefore, this investigation was designed to study the effect of clipping or grazing on survival of the species, on total production of dry matter per acre, on botanical composition and quality of the forage harvested, and on root growth.

Materials And Methods

Four field seedings, namely, New York broadleaf birdsfoot trefoil alone, Italian broadleaf birdsfoot trefoil alone, Italian broadleaf with Lincoln bromegrass (*Bromus inermis* Leyss), and Italian broadleaf with Kentucky bluegrass (*Poa pratensis*

L.) were made without a companion crop on April 19, 1949. The soil type of the plots was Flanagan silt loam, a deep, gently sloping, brown prairie soil of moderate permeability on the University of Illinois Agronomy South Farm at Urbana.

The seedings were grazed by sheep from July 14 to September 8, 1949, and they were also clipped on June 20, July 15 and August 25 in order to hold weed competition with the birdsfoot trefoil seedlings to a minimum.

In the spring of 1950, a portion of each seeding association was marked off for clipping trials, and another portion was fenced for grazing by yearling lambs. Twelve different clipping teratments were replicated four times in each of the four seedings.

Results And Discussion

Survival

New York birdsfoot trefoil plants successfully survived the effects of (a) clipping at a height of either one inch or four inches every three weeks until either late August or early October during the seasons of 1950 and 1951, (b) clipping at a height of either one inch or two inches when the plants had made a growth recovery to four inches until October each year, (c) clipping at a height of one inch when the plants had made a growth recovery of two to three inches until either late August or early October of both seasons, and (d) clipping at prebloom, one-tenth bloom and full bloom. Clipping when most of the seed was ripe in July 1951, resulted in a loss of many two-year-old plants.

Italian birdsfoot trefoil plants growing alone and with bluegrass or bromegrass survived the effects of (a) clipping at a height of four inches every three weeks until either late August or early October, and (b) clipping at prebloom, one-tenth bloom, full bloom or maturity during the seasons of 1950 and 1951.

The stand of Italian birdsfoot trefoil growing alone and

with bluegrass was reduced as a result of clipping (a) at a height of one inch every three weeks, (b) at a height of one inch when the plants had made a growth recovery of either two to three inches or four inches, and (c) at a height of two inches when the plants had made a growth recovery of four inches over the two seasons of 1950 and 1951. The reduction in stand was greater on the above plots that had been clipped until late fall than on the plots that had not been clipped after late August. Italian birdsfoot trefoil growing with bromegrass showed a slight reduction in stand as a result of clipping at a height of one inch every three weeks until either late or early fall, and for clipping at a height of one inch until late fall, whenever the plants had made a growth recovery of two to three inches. There was no reduction in the stand of Italian birdsfoot trefoil seeded with bromegrass as a result of clipping during 1950 and 1951 at a height of one or two inches until late fall whenever the plants had made a growth recovery to four inches, or as a result of clipping at a height of one inch until late August when the plants had made a growth recovery of two to three inches. Italian birdsfoot trefoil seeded with bromegrass survived close and frequent clipping better than when it was seeded alone or with bluegrass. The reason for this difference is not clear. It is doubtful that bromegrass offered more winter protection to the birdsfoot plants than bluegrass when both were clipped at a height of one inch in October. Neither is it likely that bluegrass is toxic to Italian birdsfoot because the two species performed well together when they were clipped less frequently.

No changes were observed in the stand of New York birdsfoot trefoil as a result of grazing in 1950 and 1951, whereas the Italian birdsfoot trefoil showed a slight decrease in stand when grazed during the same period.

New York birdsfoot trefoil has a prostrate type of growth which clings to the ground when it is grazed or clipped closely and frequently, whereas the Italian birdsfoot has an erect form of growth; therefore, the New York strain maintained more leaf area after these harvests than the Italian birdsfoot.

Consequently, the New York birdsfoot trefoil plants did not draw as heavily on their root reserves to initiate new growth after clipping or grazing. That may account for a better survival of the New York than of the Italian birdsfoot when both were grazed or clipped closely and frequently.

Botanical Composition

The harvested forage contained a greater percentage of birdsfoot trefoil in proportion to other species in each seeding association as a result of (a) clipping at a height of four inches versus one inch at three-week intervals, (b) clipping until early fall versus late fall of the previous season, and (c) except for Italian birdsfoot in 1950, clipping back to a height of two inches instead of one inch after the plants made a growth recovery to four inches. Clipping at the hay stage (prebloom, one-tenth bloom, full bloom and maturity) resulted in a high percentage of both strains of birdsfoot trefoil in proportion to other species.

Bromegrass and bluegrass accounted for a high percentage of the yield in the spring, especially in the first cutting of plots clipped at the hay stage in 1951, because both grasses were growing vigorously at that time. However, bromegrass and bluegrass did not have any depressing effect on later growth of Italian birdsfoot trefoil regardless of delays in the removal of the first crop, such as clipping at prebloom, one-tenth bloom, full bloom or maturity.

Both grasses reduced the precentage of weeds in 1950 on the plots clipped closely and frequently. A higher percentage of birdsfoot trefoil would normally be expected when it is seeded alone instead of being seeded with a grass; however, in 1950 birdsfoot seeded alone was infested with a higher percentage of crabgrass (*Digitaria sanguinalis* L.) than the seedings in association with bluegrass and bromegrass. As a result, the percentage of birdsfoot trefoil was slightly lower where it had been seeded alone than with bluegrass and only slightly higher than where it had been seeded with bromegrass.

This experience suggests that it is desirable to seed grasses with birdsfoot trefoil; otherwise, they may be replaced by weeds.

In 1951 Kentucky bluegrass volunteered to the extent of a full stand where New York and Italian birdsfoot trefoil had been seeded alone. The season was favorable for forage growth, and most of the crabgrass was eliminated by competition from birdsfoot trefoil, bluegrass and bromegrass.

There was a high percentage of both strains of birdsfoot trefoil in the respective pasture plots except in the seeding of Italian birdsfoot trefoil with bromegrass and with bluegrass in 1951. The exception was probably due to early spring grazing on this area in 1951, beginning May 9, and to selective grazing of birdsfoot trefoil by the sheep plus a good growth of the grasses. Early and selective grazing would have a depressing effect on the vigor of birdsfoot trefoil plants.

Yield of Dry Matter

The different clipping treatments caused similar yield responses in most cases on each of the four seeding associations.

Greater yields were obtained as a result of (a) clipping back to a height of one inch instead of four inches every three weeks in the first year (largely because a greater portion of the total production was harvested); however, the yield advantage for cutting at a height of one inch was reduced significantly by a depressed yield the second year; (b) clipping at a height of one inch instead of two inches when the plants had made a growth recovery to four inches (one extra clipping in 1950 and two extra clippings in 1951 at the two-inch height may have been more detrimental than the benefits obtained by allowing another inch of stubble); (c) allowing the plants to make a growth recovery to four inches instead of two to three inches before mowing at a height of one inch; (d) continuing mowing until October instead of only to late August in the first year (mostly because of extra cuttings); however,

the yield trend was reversed the second year because plants which had been protected from mowing on the previous fall were more productive than plants which had been clipped until late in the fall; and (e) mowing at full bloom instead of maturity or one-tenth bloom. The yield differences as a result of clipping at one-tenth versus prebloom were not consistent. The lower yield obtained from cutting at maturity instead of at the full-bloom stage may be due to the fact that vegetative growth usually slows down as a plant produces seed.

Clipping at the full-bloom stage produced the highest yield each year on each of the four seeding associations. The average yield of New York birdsfoot trefoil seeded alone, Italian birdsfoot trefoil seeded alone, Italian birdsfoot seeded with bluegrass, and Italian birdsfoot seeded with bromegrass, clipped at full bloom, was 5346, 4277, 4248, and 4138 pounds per acre, respectively, in 1950, and 7482, 7116, 8072, and 8724 pounds per acre, respectively, in 1951.

Close and frequent cutting produced the lowest yield of forage on each seeding association. For example, the average yield of dry matter obtained per acre from clipping until late fall at a height of one inch when the plants had made a growth recovery of two to three inches was 3489, 2569, 2130, and 2360 pounds in 1950, and 3835, 1920, 2429, and 3087 pounds in 1951 for New York birdsfoot, Italian birdsfoot, Italian birdsfoot with bluegrass, and Italian birdsfoot with bromegrass, respectively.

The amount of forage harvested from the pasture cages was approximately equal to the amount obtained from the plots clipped at the full-bloom stage on each seeding association both in 1950 and 1951. The average yield increased from 4506 pounds in 1950 to 8355 pounds of dry matter per acre in 1951. This increase of 85 per cent was not reflected in the pounds of animal gain which were 214 and 232 pounds per acre or an increase of only 8 per cent in 1951 over 1950. However, there was an increase in the sheep days of grazing per acre from 684 to 1251 days, or nearly 83 per cent, in 1951

over 1950. The average amount of forage dry matter produced for each sheep per day on pasture was 6.58 pounds in 1950 and 6.67 pounds in 1951. A legume-grass pasture of the type used in this trial should have furnished sufficient total digestible protein and total digestible nutrients for maintenance plus gains of .2 to .3 pounds per head per day if the yearling ewes consumed 3.5 pounds of dry matter per day. If that is the case, then the loss or waste of feed per head per day on pasture was 3.08 pounds of dry matter in 1950 and 3.17 pounds in 1951. A part of that loss is represented in the less palatable forage which is not consumed. In 1950, for example, the amount of forage not consumed was 889 pounds of dry matter per acre. That accounts for nearly 1.3 pounds out of th 3.08 pounds lost in 1950, leaving 1.78 pounds per head per day which might be charged in part to trampling. In these calculations, we have assumed that the production of forage was the same for a grazing type of defoliation as it was under the cages. The fact that the plants being grazed did not reach a stage of growth or maturity where they could synthesize carbohydrates and dry matter at the maximum rate comparable to the protected plants probably reduced the yields of the pasture as a whole compared to the yields obtained from the cages in this trial. Frequent defoliation, even at a height of four inches, decreased the total yield of forage in the clipping trials. Therefore, the cages which were clipped twice in 1950 and three times in 1951 were undoubtedly clipped too infrequently for a true measure of the forage yields under grazing conditions.

Quality of Forage

A chemical analysis of New York birdsfoot trefoil, sampled each month during the summer, showed an average of 24.6 to 27.4 per cent protein in 1950 as a result of clipping at a height of one, two to three, and four inches at intervals of three weeks or less. The percentage of protein decreased to 17.8, 18.1, 18.0 and 15.1 per cent as the plants attained pre-bloom, one-tenth bloom, full bloom and maturity, respectively.

The average percentage of protein in New York birdsfoot trefoil during the 1951 season was slightly over 20.0 per cent when the plants were clipped at a height of one or two inches after they had made a growth recovery to four inches, and similarly when they were clipped at a height of one inch after making a growth recovery of two to three inches. Plants clipped at a height of one inch every three weeks had an average protein content of 31.7 per cent compared to 17.7 per cent when they were cut at a height of four inches every three weeks. The first crop of the season clipped at prebloom, one-tenth bloom, full bloom and maturity contained 20.9, 21.2, 23.2 and 19.9 per cent protein, respectively, in 1951. The percentage of protein is satisfactory in all cases.

Root Growth

Italian birdsfoot trefoil root weights were affected by clipping treatments to a greater degree than those of the New York birdsfoot trefoil. The highest average weight of roots per plant was obtained from plants of both strains which were allowed to reach the hay stage, and from plants which were mowed so as to leave a four-inch stubble. Close and frequent cutting showed the lowest average root weights. Lower weights were found as a result of late fall versus early fall mowing of Italian birdsfoot trefoil but not of the New York strain.

Root weights under grazing conditions of Italian and New York birdsfoot trefoil plants, which attained the early bloom stage before being grazed in 1951, were similar to the weights of plants clipped at the hay stage.

Summary

New York birdsfoot trefoil survived the effects of close, frequent and late fall clipping during the seasons of 1950 and 1951 without any apparent loss of stand. The stand of Italian birdsfoot was reduced as a result of close, frequent and late fall clipping during the same period. Both strains survived

the effects of mowing every three weeks at a height of four inches, or mowing at prebloom, one-tenth bloom and full bloom. Italian birdsfoot survived the effect of mowing at maturity, whereas many two-year-old plants of New York birdsfoot did not survive after being clipped in the seed stage. New York birdsfoot survived the ecects of grazing during 1950 and 1951, whereas the Italian birdsfoot showed a slight reduction in stand.

New York birdsfoot was more productive than the Italian birdsfoot each year when both were clipped or grazed in a similar manner. Clipping either strain at the full-bloom stage produced the highest yield each year on each seeding association.

The studies on botanical composition, forage yields and root growth indicate that the clipping treatments which favored a high percentage of birdsfoot trefoil in proportion to other species generally favored a vigorous top growth of both strains of birdsfoot trefoil and a heavy weight of roots per plant.

Clipping treatments which usually showed a beneficial response were (a) clipping at a height of four inches rather than one inch at three-week intervals, (b) deferred clipping until the birdsfoot plants attained the prebloom, one-tenth bloom or full-bloom stage, (c) repeated mowing until only early fall rather than late fall of the previous season, and (d) allowing the plants to make a growth recovery to four inches instead of two to three inches before mowing at a height of one inch. The root weights of New York birdsfoot were not benefitted by treatments (c) and (d) mentioned above.

Bromegrass and bluegrass were desirable species in association with birdsfoot trefoil. They held down the percentage of weeds, and they had no depressing effect on the growth or vigor of birdsfoot trefoil in any of the twelve different clipping treatments. In fact, the yields were higher as a result of seeding Italian birdsfoot with bromegrass and

bluegrass instead of seeding it alone.

Animal gains did not reflect the difference in forage yields from one season to the next. Sheep days of grazing per acre per year showed a positive correlation with dry-matter production. There was an increase of 85 per cent in forage yields, 83 per cent in sheep days of grazing, and only 8 per cent in pounds of gain per acre in 1951 over 1950.

The chemical analyses of New York birdsfoot trefoil sampled each month during the summer of 1950 and 1951 show that the percentage of protein in the plants which were clipped at different stages of growth and maturity was sufficient to make New York birdsfoot trefoil a high-quality protein feed.

VITA

Joseph Julian Pierre was born on April 17, 1911, in Brussels, Wisconsin. After graduating from Brussels High School in 1928, he entered the University of Wisconsin and received the degree of Bachelor of Science from that institution in 1932. He then bought and operated a dairy farm at Brussels until 1935. While operating the farm he also worked as a case worker for the Door County Emergency Relief Administration from May 1934 until July 1935. In July 1935 he began working for the Soil Conservation Service. Positions held with this organization since then were Senior Foreman of Laborers at West Salem, Wisconsin, until September 1937; Junior Agronomist at Bloomington, Wisconsin, until October 1939; Assistant Agronomist at Fennimore, Wisconsin, until June 1941; Assistant Soil Conservationist at Lancaster, Wisconsin, until January 1945; Associate Agronomist at Urbana, Illinois, until August 1951; and Agronomist as of this date. He is currently working in the states of Illinois, Indiana and Missouri.

While on leave from the Soil Conservation Service, he took one quarter of graduate work at the University of Minnesota in the spring of 1940. He entered the graduate college of the University of Illinois, on a part-time basis, in February 1946, and received the degree of Master of Science in Agronomy in June 1947.

He is the author or co-author of two scientific and three popular articles which were published during the past year. In addition, he is co-author of Purdue University Station Circular 348 and Mineographs AG1377 and AG1405 of the University of Illinois College of Agriculture.

He is a member of Gamma Sigma Delta, Sigma Xi, the American Society of Agronomy and the Soil Conservation Society of America.

He is married and has three sons and three daughters.